

CLAIMS

**WHAT IS CLAIMED:**

1. A harmonic mixer comprising:  
5 a multiplier circuit comprising first and second mixers; and  
a generator for generating two first and two second control signals for controlling said  
first and second mixers,  
wherein said two first and two second control signals are balanced signals and are  
provided in four phases each shifted by  $\pi/2$  in phase, and  
10 said control signals having a frequency different from a frequency of a mixer input  
signal.
2. The harmonic mixer of claim 1, wherein said multiplier circuit is a Gilbert cell  
having a plurality of transistors, where all said transistors are used as switches.
3. The harmonic mixer of claim 1, wherein said generator comprises a voltage  
15 controlled oscillator.
4. The harmonic mixer of claim 1, wherein the frequency of said control signals  
20 is half the frequency of the mixer input signal.
5. The harmonic mixer of claim 1, wherein said first mixer has a pair of field  
effect transistors and said second mixer has two pairs of field effect transistors.

6. A harmonic direct conversion mixer for I/Q quadrature phase modulation, comprising:

a first multiplier circuit comprising first and second mixers for generating inphase (I) components;

a second multiplier circuit comprising third and fourth mixers for generating quadrature (Q) components; and

a generator for generating two first and two second control signals for controlling said first and second mixer and two third and two fourth control signals for controlling said third and fourth mixer,

wherein said two first, two second, two third and two fourth control signals are balanced signals,

a phase shift of  $\pi/2$  between said two first and two second control signals is provided,

a phase shift of  $\pi/2$  between said two third and two fourth control signals is provided,

a phase shift of  $\pi/4$  between said two first and two second control signals and said two third and two fourth control signals is provided, and

said control signals having a frequency different from a frequency of a mixer input signal.

7. The harmonic mixer of claim 6, wherein said first and second multiplier circuits each comprise a Gilbert cell having a plurality of transistors, where all said transistors are used as switches.

8. The harmonic mixer of claim 6, wherein said generator comprises a voltage controlled oscillator and a filter bank.

9. The harmonic mixer of claim 6, wherein the frequency of said control signals is half the frequency of the mixer input signal.

10. The harmonic mixer of claim 6, wherein said first and third mixers each comprise a pair of field effect transistors and said second and fourth mixers each comprise two pairs of field effect transistors.

11. The harmonic mixer of claim 8, wherein said filter bank comprises:  
an initial  $\pi/4$  phase shifter; and  
first and second polyphase filters for generating said eight control signals.

12. The harmonic mixer of claim 11, wherein said  $\pi/4$  phase shifter has first and second all-pass filters providing first and second differential signals shifted by  $\pi/4$ .